

ROPES & KNOTS QUARTERLY

Essentials 3rd Edition

Pages 111-128

MP's 504.03, 504.05, 880.01

Supplement to the Essentials
(LFR Drill Manual-on line)

GOALS & OBJECTIVES

- FF shall demonstrate proper knowledge and skills of basic rope principles.
- FF shall demonstrate proper knots and application.
- Both to the satisfaction of the officer.
- FF given a review of LF&R ropes & knots based on IFSTA essentials and LFR MP's, shall demonstrate proper knowledge and practical skills to the satisfaction of the company officer.

ROPE MATERIALS

- Natural Fibers
- Manila
- Sisal
- Cotton
- Synthetic Fibers
- Nylon
- Polypropylene
- Polyethylene
- Polyester
- Kevlar Aramid Fiber

Rope materials-the material used to construct fire service rope is in 2 different categories: natural fibers and synthetic fibers.

Natural fiber-was primary type of rope used for rescue, after testing it is no longer accepted for life safety use. It is still ok to use for utility purposes.

Manila (natural)-manila is strong, comes from leaf of a plant, usually identified with a colored string twisted into the fiber. It's tensile strength is not as good as nylon. The rope is subject to normal rot and decay from the environment. Manila deteriorated rapidly over time and its tensile strength is reduced also. Once manila gets wet it loses ½ of its tensile strength. If stored in a humid atmosphere it will lose ½ its strength in one year. The rope is severely affected by chemicals, charring and abrasion, if exposed to either of these it should be disposed of.

Sisal (natural)-a hard fiber with ¾ the tensile strength of manila.

Cotton (natural)-soft, pliable, tensile strength slightly less than sisal and a lot less than manila. Very susceptible to abrasion.

Synthetic fibers-use is common in the fire service. Advances in synthetic rope makes it preferable to natural fiber, especially in life safety use. Synthetic fiber has excellent resistance to mildew & rotting, excellent strength and maintenance is easy. Synthetic rope has continuous fibers running the entire length of the rope, natural fiber has short overlapping strands of fiber.

Nylon (synthetic)- One of the best materials used for ropes, it has a high resistance to abrasion, high tensile strength, and is resistant to moisture and most chemicals. (except acids) Nylon is 3-3 ½ times as strong as manila which allows the use of a smaller rope (they are easier to handle and take less space for storage.) Nylon rope resists wear and abrasion and works fairly well when wet (maintains 75-80% of strength when wet). Nylon rope cannot be easily formed into solid knots and hitches, and stretches under load.

Polypropylene (synthetic)- Very light weight, is water resistant and floats on water so it is popular in water rescue. Has good resistance to rotting, mildew, and abrasion. Polypropylene has moderate elastic capacity, is quickly affected by heat. Polypropylene is difficult to secure into good knots and hitches.

Polyethylene (synthetic)-Similar to polypropylene in weight, strength, elasticity, and chemical and abrasion resistance. Will float indefinitely. Polyethylene is not easily formed into knots and hitches.

Polyester (synthetic)- Used where high strength, low stretch rope is needed. Polyester is not subject to damage from water, sunlight, most chemicals, or moderately high temps.

Kevlar Aramid Fiber (synthetic)- Kevlar has high tensile strength and heat resistance. (used for production of bullet proof vests.) Kevlar can be damaged by abrasion so it is sheathed in another material, such as nylon or polyester. Not used much for rescue due to low shock absorbing ability, is hard to tie into knots.

ROPE CONSTRUCTION

- Laid (twisted) natural or synthetic ropes
- Braided rope
- Braid-on-braid rope
- Kernmantle rope

Rope falls into 1 or 2 categories: static or dynamic.

Static rope stretches very little under normal loads.

Dynamic lines stretch more than static both under weight and shock loads. Static is preferred for rescue work in most cases.

Laid-All natural fiber ropes and some synthetic fiber ropes are of laid construction. Hard-laid rope is twisted tightly to form a stiffer more abrasion resistant rope. It is difficult to form knots and hitches and must be tied off with a safety knot. Soft laid rope is not twisted as tight, is softer, more easily tied and somewhat stronger. Laid ropes are constructed by twisting together yarns to form strands. It is susceptible to abrasion and other types of physical damage because it leaves all 3 load-bearing strands exposed at various points all along the rope.

Braided rope- Some braided ropes are made from natural fibers but most are synthetic. It is constructed by uniformly intertwining strands of rope together. This type has no outer sheath or core so it is susceptible to abrasion and damage.

Braid-on-braid- It is a jacketed rope and is often confused with kernmantle. It is constructed with a braided core and a braided sheath. It is very strong, does not resist abrasion and has a problem of the outer sheath sliding along the inner core.

Kernmantle- jacketed rope composed of a braided covering (mantle) over the main load-bearing strands (kern). They may be twisted or braided. Has good stretch resistance and load characteristics. The kern is made of high strength fibers which account for $\frac{3}{4}$ of the total strength of the rope. With this construction, the sheath absorbs most of the abrasion and protects the load bearing core. Kernmantle can be dynamic or static. Dynamic kernmantle is most commonly used as a sport rope for rock or ice climbing. Static is used for rescue rope.

ROPE CLASSIFICATION

- Life Safety
- Utility

Life safety- used to support rescuers and/or victims NFPA 1983 sets the standards due to high degree of safety required. Only rope constructed of continuous filament fiber is suitable for life safety, it should be used only once and then taken out of service. (it may be reused for training)

Utility rope is used any time excluding life safety applications, (where rope is required). Utility rope can be used to hoist equipment, secure unstable objects, or cordon off an area. The only standard is to regularly inspect and check for damage.

KNOTS

- Good knots should be easy to tie, identify, untie and strong enough to do the job.
- The newer synthetic rescue rope is much smoother and slicker, it is more likely to slide on itself than natural fiber rope.
- Old knots can slip under load, some sort of safety is required.
- Elements of a knot:

Knots weaken a rope because the rope is bent in order to form the knot. The fibers on the outside of the knot are stretched, and the fibers on the inside of the knot are crushed. Sharper bends weaken the rope more than a knot with easy bends.

Bight-formed by simply bending the rope back on itself while keeping sides parallel.

Loop- the loop is made by crossing the side of a bight over the standing part.

Round turn- the round turn consists of further bending one side of a loop.

Knots and hitches are formed by combining these elements in different ways so that the tight part of the rope bears on the free end to hold it in place. Fire service knots should be able to be rapidly tied, easily untied, not subject to slippage and have a minimum of abrupt bends.

PARTS OF THE ROPE

- Running part-part of rope used for work
 - Ex. Hoisting, pulling, or belaying
- Working end-part of rope used in forming the knot
- Standing part-part of rope between the working end and the running part

BOWLINE

- The bowline is easily untied and is a good knot for forming a loop that will not constrict the object it is placed around.
- Should be used on natural fiber rope only.
- Not secure on synthetic rope-don't use in life safety situations.
- See pg. 117-118 of essentials for directions on tying knot.

THE CLOVE HITCH

- The clove hitch may be formed several methods, consists of two half hitches.
- Principal use is to attach a rope to an object such as a pole, post or hose.
- May be formed anywhere in the rope (end or middle).
- When properly applied it will stand a pull in either direction with out slipping.
- See pg 118-119 essentials for directions

HALF HITCH

- The half hitch is useful in stabilizing tall objects that are being hoisted.
- Always used in conjunction with another knot.
- Several half hitches can be used in succession if needed.
- See pg. 119 essentials for directions on tying knot

FIGURE EIGHT KNOTS

- With the use of synthetic rope, the figure eight knots have been introduced.
- Figure eight has replaced the bowline.
- Figure eights are tighter and stronger.
- Will not damage synthetic rope as easily.
- See pg 120-121 essentials for directions on figure eight family of knots.

OVERHAND SAFETY KNOT

- The overhand safety knot is an added measure of safety whenever tying any knot.
- Provides the highest level of safety possible, eliminates chance of end of rope slipping through the knot.
- See pg. 122 essentials.

PIKE POLE

- The pike pole is tied by using a clove with an overhand safety at the handle end of the pike pole, and 2 ½ hitches with the last one under the hook.
- See pg. 119 essentials.

AXE

- You can use the directions for the axe tie in the third or fourth edition of the essentials.
- Pg. 127-128 3rd essentials, directions from 4th ed. (attached).

AXE-4TH EDITION



LADDER

- The figure eight knot has replaced the bowline for this.
- Pg. 128 essentials

HOSELINES

- Methods for hoisting dry and charged hose lines are listed on pg. 128 essentials.

SMOKE EJECTOR

- The figure eight has replaced the bowline for this tie.
- Pg. 128-129 essentials.

OTHER KNOTS/HOISTS

- Fire extinguisher
- Roof ladder-alternate method
- Chimney hitch
- Scoop shovel
- Johnson bar
- Tarp
- Munter hitch
- Water knot
- Handcuff knot
- Prusik

Prusik



Prusik



Prusik



Double Fisherman's



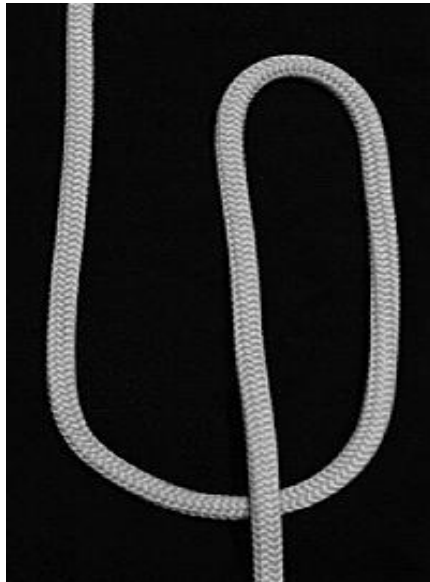
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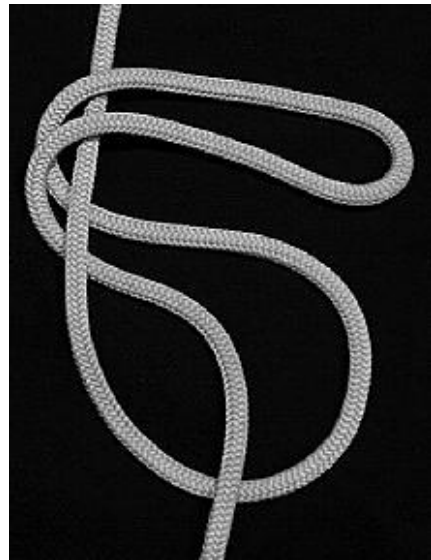
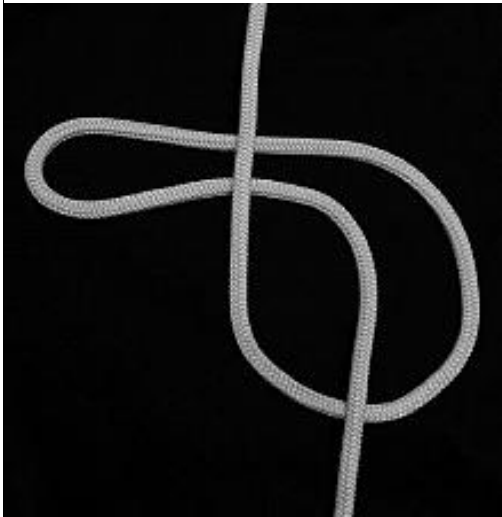
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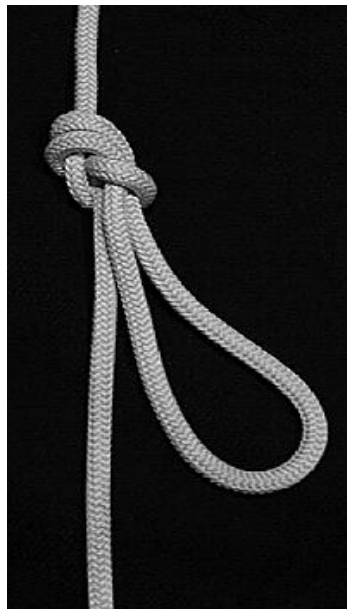
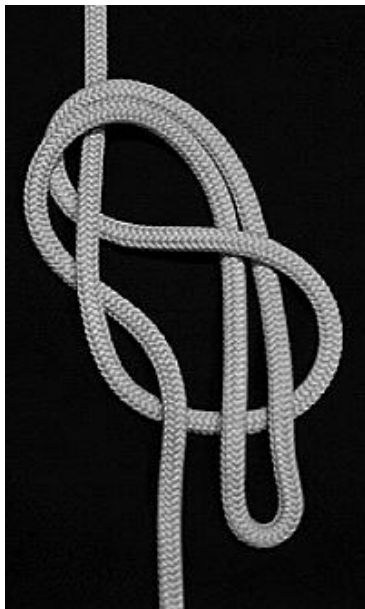
In-Line Figure 8



In-Line Figure 8



In-Line Figure 8



ROPE MAINTENANCE

- All ropes should be inspected after each use.
- A rope log should be kept with each rope.
- Rope can be washed by hand or in a washer without an agitator.
- Coil rope before washing.
- Dry thoroughly before storing.
- Do not dry in sun light.

ROPE STORAGE

- Rope should be stored in compartments away from fuel and tools.
- Rope should be stored in canvas bags.
- Rope should be placed in the bags so that it will play out easily.

SKILLS CHECK OFF SHEET

2003 1ST QUARTER

ROPES & KNOTS

- NAME _____
- DATE _____
- RIG/SHIFT _____
- CAPTAIN SIGNATURE _____

DEFINE:

1. STANDING PART:

2. RUNNING PART:

3. BIGHT:

4. LOOP:

5. ROUND TURN:

- 1st = passed on first attempt
 - 2nd = passed on second attempt
 - N/I = can tie knot but needs improvement
-
- Using departmental standards, firefighter shall tie all knots used by the department:

1. CLOVE: 1ST _____ 2ND _____ N/I _____
2. CHIMNEY HITCH: 1ST _____ 2ND _____ N/I _____
3. WATER KNOT (WEBBING): 1ST _____ 2ND _____ N/I _____
4. FIGURE 8 ON A BIGHT: 1ST _____ 2ND _____ N/I _____
5. FIGURE 8: 1ST _____ 2ND _____ N/I _____
6. CANADIAN 8: 1ST _____ 2ND _____ N/I _____
7. RETRACED FIGURE 8: 1ST _____ 2ND _____ N/I _____
8. 1 ¾ HOSE LINE W/NOZZLE (CHARGED): 1ST _____ 2ND _____
N/I _____
9. 1 ¾ HOSE LINE W/NOZZLE (UNCHARGED): 1ST _____ 2ND _____
N/I _____
10. AXE: 1ST _____ 2ND _____ N/I _____



10. AXE: 1ST _____ 2ND _____ N/I _____

11. JOHNSON BAR: 1ST _____ 2ND _____ N/I _____

12. FIRE EXTINGUISHER: 1ST _____ 2ND _____ N/I _____

13. ROOF LADDER: 1ST _____ 2ND _____ N/I _____

14. TARP: 1ST _____ 2ND _____ N/I _____

15. SHOVEL: 1ST _____ 2ND _____ N/I _____

16. PIKE POLE: 1ST _____ 2ND _____ N/I _____

17. PRUSIK; 1st _____ 2nd _____ N/I _____

18 Double Fishermans: 1st _____ 2nd _____ N/I _____

19 In-Line Figure 8: 1st _____ 2nd _____ N/I _____